Physics 131
General Physics I
Grinnell College

Homework XII

Session XII.2

1. In Unit XI, we considered waves that were confined to a hoop. Those quantum waves can run in either direction, that is, go around as R O Y G T B I V R, or as R V I B T G Y O R. What would happen if you made a superposition of those two waves going in opposite directions? Consider the case with only one wavelength around the circle, and sketch your answer with a few words of explanation.

2. Let's extend problem 1 to three dimensions. The quantization of waves in the ϕ direction for the hydrogen atom is very much like waves on a hoop. Consider the same sort of superposition as described in problem 1 for the (0 0 1) state and the (0 0 -1) state of the hydrogen atom. Sketch what you think the result would look like, and describe this in a few words. (For you physical chemists, this is a p_X wave function.)

3. A wave function at a particular point in time has no angular dependence in the color wave, but consists of a central core that is red, a green shell around that, a red shell around that, and a final green shell around that. What are the quantum numbers n_r, n_θ, and n_ϕ for that wave function?

Session XII.3

4. A hydrogen atom has two radial nodes and three angular nodes, two of which are in the ϕ direction. What are the traditional n, l, m_l quantum numbers of this atom? What is the total angular momentum of this atom?

5. Sketch what the atomic wave function for the atom in problem 4 looks like.

6. An atom has 11 electrons in it. If this is in the ground state, and nature likes to fill lower angular momentum states first (if she can't decide on the basis of n, since n has first priority), what are the n, l, m_l quantum numbers of the state of this last electron? What are our corresponding radial, θ, and ϕ quantum numbers for that same state?